

PRELIMINARY DATA SUMMARY

March 1990

U.S. Army Engineer Waterways Experiment Station
Coastal Engineering Research Center
Field Research Facility
Duck, North Carolina

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CERC Field Research Facility
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

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PART I: INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.6 m above the National Geodetic Vertical Datum (NGVD). In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Michael W. Leffler at (919) 261-3511.

Part II presents the meteorological data; Parts III through VI present oceanographic data; Part VII presents nearshore profiles and bathymetry; and Part VIII, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used, their operational status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depths at the wave gages and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

Times given in the report, unless otherwise specified, are referenced to eastern standard time (EST).

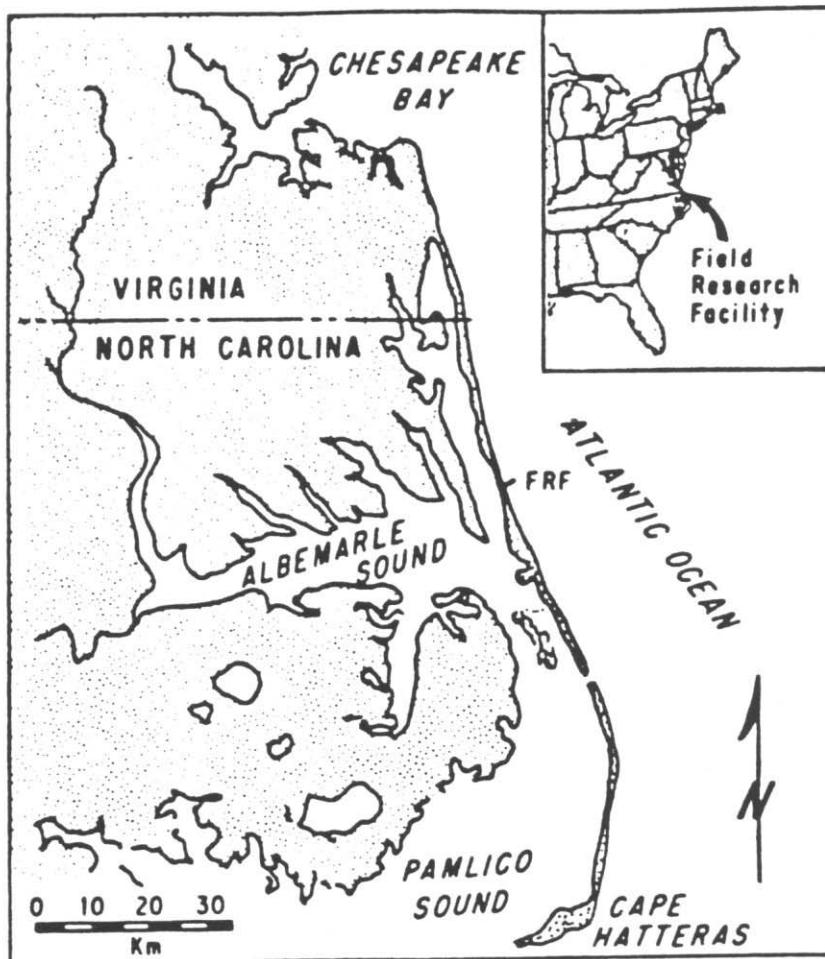


Figure 1. FRF location map

Table 1: Instrument Status/Data Availability

MAR 1990

| | | | |
|---------------------|-------------------|---------------|----------------|
| Gage Status | Daily Observation | Analog Record | Data Collected |
| Operational = * | Complete = * | Complete = * | All = * |
| Partial = / | Partial = / | Partial = / | Partial = / |
| Non-Operational = - | None = - | None = - | None = - |

True North

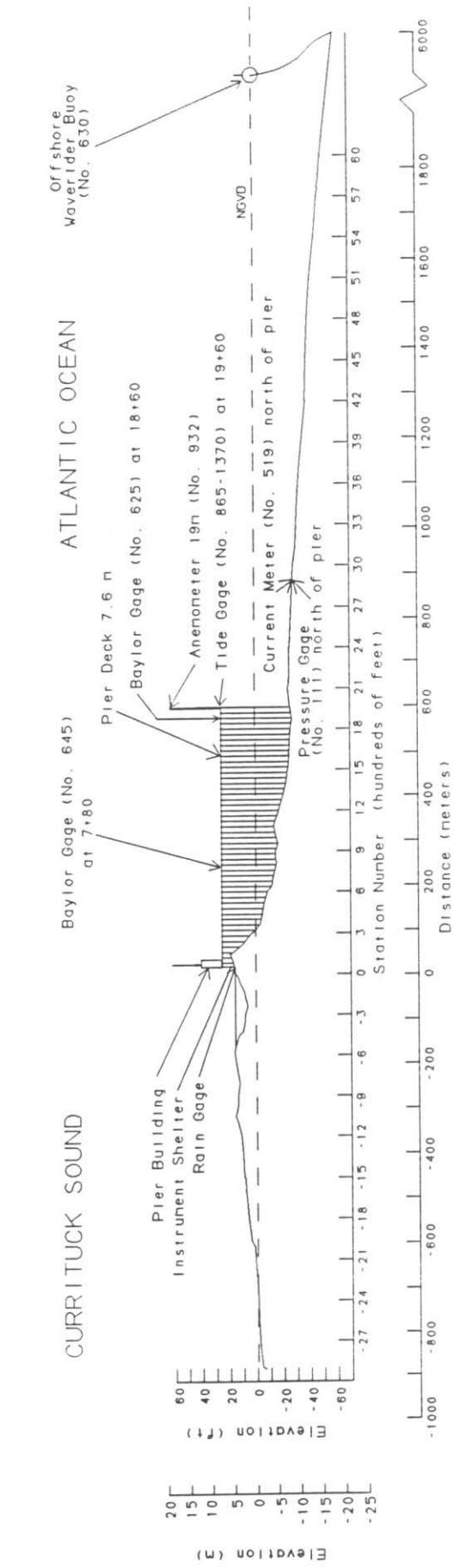
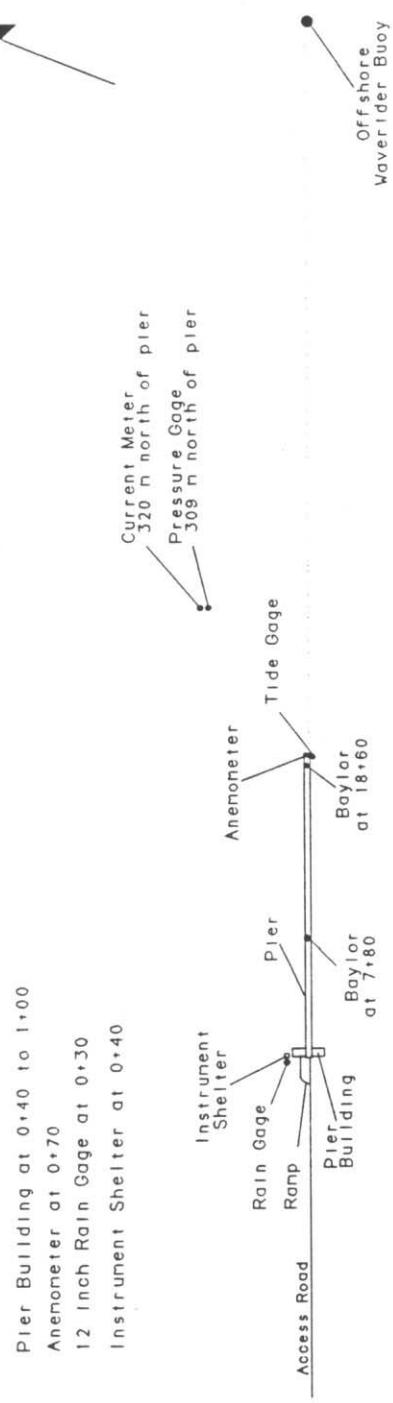



Figure 2. Instrument locations at FRF (all elevations from NGVD, all distances from FRF baseline).

PART II: METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m (Figure 2) using a Weather Measure Skyvane anemometer.

Monthly resultant wind speeds and directions are determined by vector averaging the data. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -
 $m/s \times 1.943 = kn$

Table 2: Meteorological Data

| Mar 1990 | | | | | | |
|----------|------|----------------|---------------------|-------------|----------------|---------------|
| Day | Hour | Wind | Wind | Temperature | Atm | Precipitation |
| | | Speed m/sec | Direction deg TN | deg C | Pressure mb | mm |
| 1 | 100 | 2 | 96 | 7.4 | 1024.3 | 0 |
| | 700 | 11 | 13 | 5.8 | 1027.7 | 0 |
| | 1300 | 7 | 17 | 4.9 | 1028.7 | 0 |
| | 1900 | 4 | 60 | 3.7 | 1027.0 | 0 |
| 2 | 100 | 3 | 136 | 3.6 | 1024.0 | 0 |
| | 700 | 3 | 154 | 6.0 | 1020.9 | 0 |
| | 1300 | 2 | 142 | 11.1 | 1016.9 | 0 |
| | 1900 | 5 | 157 | 10.0 | 1014.8 | 0 |
| 3 | 100 | 7 | 154 | 9.6 | 1010.4 | 0 |
| | 700 | 2 | 180 | 10.9 | 1006.4 | 30 |
| | 1300 | 5 | 348 | 12.4 | 1003.7 | 0 |
| | 1900 | 8 | 1 | 7.9 | 1007.0 | 0 |
| 4 | 100 | 4 | 325 | 7.0 | 1009.8 | 0 |
| | 700 | 16 | 350 | 4.9 | 1015.5 | 0 |
| | 1300 | 11 | 353 | 4.0 | 1019.2 | 0 |
| | 1900 | 6 | 24 | 3.7 | 1021.6 | 0 |
| 5 | 100 | 5 | 64 | 4.5 | 1023.6 | 0 |
| | 700 | 6 | 73 | 6.7 | 1025.7 | 0 |
| | 1300 | * | * | 9.5 | 1026.3 | 0 |
| | 1900 | * | * | 8.1 | 1025.0 | 0 |
| 6 | 100 | * | * | 8.2 | 1024.3 | 0 |
| | 700 | * | * | 8.7 | 1024.7 | 0 |
| | 1300 | * | * | 13.9 | 1024.3 | 0 |
| | 1900 | * | * | 8.7 | 1026.0 | 0 |
| 7 | 100 | * | * | 5.4 | 1030.7 | 0 |
| | 700 | * | * | 3.5 | 1034.8 | 0 |
| | 1300 | 13 | 18 | 3.2 | 1037.2 | 0 |
| | 1900 | 10 | 25 | 3.0 | 1037.5 | 0 |
| 8 | 100 | 7 | 19 | 2.5 | 1036.5 | 0 |
| | 700 | 8 | 35 | 3.4 | 1034.8 | 0 |
| | 1300 | 5 | 30 | 5.5 | 1033.8 | 0 |
| | 1900 | 3 | 97 | 4.6 | 1031.4 | 0 |
| 9 | 100 | 3 | 158 | 5.4 | 1028.0 | 0 |
| | 700 | 5 | 212 | 7.3 | 1025.0 | 0 |
| | 1300 | 11 | 244 | 14.1 | 1021.3 | 0 |
| | 1900 | 4 | 230 | 11.5 | 1018.9 | 0 |
| 10 | 100 | 7 | 249 | 10.2 | 1018.9 | 0 |
| | 700 | 4 | 293 | 10.0 | 1020.9 | 0 |
| | 1300 | 4 | 1 | 11.3 | 1023.3 | 0 |
| | 1900 | 5 | 83 | 9.0 | 1023.0 | 0 |
| 11 | 100 | 3 | 212 | 9.0 | 1023.3 | 0 |
| | 700 | 4 | 199 | 11.8 | 1023.0 | 0 |
| | 1300 | 6 | 203 | 22.0 | 1020.9 | 0 |
| | 1900 | 7 | 197 | 17.7 | 1020.6 | 0 |
| 12 | 100 | 6 | 218 | 14.8 | 1020.9 | 0 |
| | 700 | 7 | 223 | 15.0 | 1020.9 | 0 |
| | 1300 | 6 | 235 | 24.0 | 1019.6 | 0 |
| | 1900 | 4 | 173 | 20.5 | 1018.9 | 0 |
| 13 | 100 | 6 | 233 | 16.4 | 1018.6 | 0 |
| | 700 | 5 | 228 | 16.2 | 1018.9 | 0 |
| | 1300 | 3 | 12 | 24.8 | 1018.2 | 0 |
| | 1900 | 4 | 92 | 16.9 | 1017.2 | 0 |
| 14 | 100 | 2 | 205 | 16.3 | 1016.5 | 0 |
| | 700 | 5 | 227 | 17.2 | 1017.5 | 0 |
| | 1300 | 3 | 238 | 26.9 | 1017.2 | 0 |
| | 1900 | 8 | 193 | 20.2 | 1017.2 | 0 |
| 15 | 100 | 6 | 222 | 17.5 | 1018.9 | 0 |
| | 700 | 4 | 216 | 17.4 | 1020.3 | 0 |
| | 1300 | 7 | 179 | 25.9 | 1019.9 | 0 |
| | 1900 | 8 | 184 | 20.1 | 1019.6 | 0 |
| 16 | 100 | 5 | 189 | 17.6 | 1020.6 | 0 |
| | 700 | 6 | 186 | 17.9 | 1019.2 | 0 |
| | 1300 | 8 | 203 | 24.4 | 1018.2 | 0 |
| | 1900 | 9 | 183 | 20.1 | 1016.5 | 0 |

* electronic problems

(Continued)

Table 2: Meteorological Data

Mar 1990

| Day | Hour | Wind | Wind | Temperature | Atm | Precipitation |
|-----|------|----------------|---------------------|---------------|--------|---------------|
| | | Speed m/sec | Direction deg TN | deg C | mb | mm |
| 17 | 100 | 10 | 183 | 19.8 | 1015.9 | 0 |
| | 700 | 9 | 190 | 20.2 | 1013.5 | 0 |
| | 1300 | 13 | 188 | 24.0 | 1009.4 | 0 |
| | 1900 | 9 | 244 | 19.1 | 1009.1 | 0 |
| | 18 | 100 | 7 | 183 | 18.8 | 0 |
| | 700 | 6 | 342 | 9.9 | 1010.4 | 50 |
| | 1300 | 6 | 137 | 12.8 | 1014.5 | 0 |
| | 1900 | 5 | 163 | 13.9 | 1017.2 | 0 |
| 19 | 100 | 1 | 205 | 12.6 | 1020.3 | 0 |
| | 700 | 5 | 157 | 11.7 | 1020.9 | 0 |
| | 1300 | 8 | 111 | 14.5 | 1018.9 | 0 |
| | 1900 | 7 | 158 | 15.0 | 1015.9 | 0 |
| | 20 | 100 | 4 | 150 | 14.6 | 0 |
| | 700 | 14 | 334 | 8.0 | 1013.1 | 0 |
| | 1300 | 9 | 297 | 5.8 | 1013.5 | 0 |
| | 1900 | 10 | 296 | 5.6 | 1015.9 | 0 |
| 21 | 100 | 11 | 290 | 3.0 | 1018.2 | 0 |
| | 700 | 9 | 294 | 3.1 | 1021.6 | 0 |
| | 1300 | 6 | 345 | 11.3 | 1021.9 | 0 |
| | 1900 | | | | | 0 |
| | 22 | 100 | | Power Failure | | 0 |
| | 700 | | | | | 0 |
| | 1300 | 5 | 146 | 15.4 | 1025.3 | 0 |
| | 1900 | 8 | 177 | 14.7 | 1022.3 | 0 |
| 23 | 100 | 7 | 191 | 13.5 | 1020.9 | 0 |
| | 700 | 10 | 226 | 15.0 | 1019.6 | 0 |
| | 1300 | 6 | 220 | 20.1 | 1018.6 | 0 |
| | 1900 | 3 | 218 | 17.3 | 1018.6 | 0 |
| | 24 | 100 | 14 | 25 | 9.9 | 0 |
| | 700 | 12 | 41 | 8.9 | 1023.6 | 0 |
| | 1300 | 11 | 7 | 9.5 | 1022.3 | 0 |
| | 1900 | 11 | 12 | 7.2 | 1023.0 | 0 |
| 25 | 100 | 8 | 29 | 7.8 | 1022.6 | 0 |
| | 700 | 11 | 11 | 8.2 | 1023.0 | 0 |
| | 1300 | 8 | 9 | 8.6 | 1023.3 | 0 |
| | 1900 | 4 | 14 | 7.3 | 1023.0 | 0 |
| | 26 | 100 | 5 | 360 | 7.1 | 0 |
| | 700 | 6 | 343 | 6.9 | 1023.3 | 0 |
| | 1300 | 6 | 6 | 9.0 | 1022.6 | 0 |
| | 1900 | 4 | 81 | 8.2 | 1021.6 | 0 |
| 27 | 100 | 4 | 26 | 8.7 | 1021.9 | 0 |
| | 700 | 10 | 36 | 8.8 | 1023.6 | 0 |
| | 1300 | 9 | 15 | 7.6 | 1026.0 | 0 |
| | 1900 | 9 | 29 | 5.7 | 1026.7 | 0 |
| | 28 | 100 | 8 | 56 | 5.9 | 0 |
| | 700 | 8 | 62 | 7.1 | 1029.1 | 0 |
| | 1300 | 4 | 67 | 10.0 | 1028.7 | 0 |
| | 1900 | 7 | 75 | 8.5 | 1026.7 | 0 |
| 29 | 100 | 8 | 72 | 9.8 | 1026.3 | 0 |
| | 700 | 11 | 68 | 10.4 | 1025.7 | 0 |
| | 1300 | 13 | 50 | 10.3 | 1025.3 | 0 |
| | 1900 | 14 | 66 | 12.2 | 1021.9 | 8 |
| | 30 | 100 | 8 | 115 | 12.5 | 18 |
| | 700 | 8 | 261 | 10.2 | 1017.5 | 4 |
| | 1300 | 5 | 278 | 11.4 | 1018.9 | 0 |
| | 1900 | 3 | 295 | 10.4 | 1018.9 | 0 |
| 31 | 100 | 1 | 85 | 9.5 | 1017.9 | 0 |
| | 700 | 4 | 81 | 9.8 | 1015.5 | 0 |
| | 1300 | 6 | 357 | 9.6 | 1013.1 | 0 |
| | 1900 | 3 | 1 | 9.7 | 1011.8 | 3 |
| | | Resultant | | Mean | Mean | Total |
| | | 1 | 29 | 11.3 | 1020.8 | 113 |

* electronic problems

(Sheet 2 of 2)

PART III: WAVE DATA

Wave data are collected from two Baylor staff gages (Gages 625 and 645), a pressure wave gage (Gage 111) and a Waverider buoy (Gage 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 6 hr (more frequently during storms) beginning at 0100, 0700, 1300, and 1900 EST. The sampling rate is two times per second for four contiguous 34-min records.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gage has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to magnetic tape.

Table 3 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed from this data. Figure 3 is a time history of all H_{mo} and T_p values obtained for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, or the presence of multiple wave trains containing nearly equal energy.

Table 3: Wave Data

Mar 1990

| Day | Hour | 645 | | 625 | | 111 | | 630 | |
|-----|------|-------------------------|-------|--------------------------|-------|------------------------|-------|-----------------------|-------|
| | | Baylor at 7+80 Hmo,m | T.sec | Baylor at 18+60 Hmo,m | T.sec | Pressure Gage Hmo,m | T.sec | Offshr Wvrdr Hmo,m | T.sec |
| 1 | 0100 | 0.42 | 10.67 | 0.54 | 10.24 | 0.54 | 11.13 | 0.61 | 9.85 |
| | 0700 | 1.20 | 4.27 | 1.08 | 4.20 | 1.17 | 4.13 | 1.30 | 4.34 |
| | 1300 | 1.27 | 5.57 | 1.10 | 5.45 | 1.19 | 5.69 | 1.41 | 5.45 |
| | 1900 | 0.74 | 5.33 | 0.78 | 10.24 | 0.82 | 5.57 | 0.94 | 5.95 |
| 2 | 0100 | 0.55 | 5.95 | 0.63 | 11.13 | 0.69 | 11.13 | 0.74 | 10.67 |
| | 0700 | 0.51 | 10.67 | 0.64 | 10.67 | 0.71 | 10.67 | 0.80 | 10.67 |
| | 1300 | 0.36 | 10.67 | 0.61 | 10.67 | 0.66 | 10.67 | 0.62 | 11.13 |
| | 1900 | 0.42 | 11.13 | 0.50 | 11.13 | 0.61 | 10.24 | 0.66 | 10.24 |
| 3 | 0100 | 0.39 | 11.64 | 0.56 | 10.24 | 0.63 | 11.13 | 0.70 | 11.13 |
| | 0700 | 0.53 | 10.67 | 0.61 | 10.67 | 0.72 | 11.13 | 0.77 | 10.67 |
| | 1300 | 0.46 | 8.53 | 0.62 | 10.67 | 0.76 | 10.24 | 0.77 | 10.67 |
| | 1900 | 0.91 | 4.13 | 0.97 | 10.24 | 1.04 | 4.00 | 0.96 | 10.24 |
| 4 | 0100 | 0.71 | 4.83 | 0.83 | 10.24 | 0.90 | 9.48 | 0.92 | 10.24 |
| | 0700 | 2.15 | 6.40 | 1.93 | 6.09 | 2.44 | 6.09 | 1.95 | 6.24 |
| | 1300 | 1.52 | 6.56 | 1.43 | 6.56 | 1.68 | 6.74 | 1.50 | 6.24 |
| | 1900 | 1.17 | 6.40 | 1.11 | 7.76 | 1.19 | 7.76 | 1.13 | 8.83 |
| 5 | 0100 | 0.86 | 6.56 | 1.07 | 8.53 | 1.08 | 9.14 | 0.96 | 8.26 |
| | 0700 | 0.78 | 8.83 | 0.87 | 8.26 | 0.91 | 7.76 | 0.84 | 8.26 |
| | 1300 | 0.65 | 8.26 | 0.93 | 8.53 | 0.94 | 8.83 | 0.83 | 8.26 |
| | 1900 | 0.62 | 8.83 | 0.75 | 8.83 | 0.83 | 8.83 | 0.69 | 8.00 |
| 6 | 0100 | 0.52 | 14.22 | 0.73 | 8.00 | 0.79 | 8.53 | 0.63 | 7.53 |
| | 0700 | 0.54 | 5.57 | 0.72 | 5.02 | 0.76 | 13.47 | 0.61 | 7.76 |
| | 1300 | 0.44 | 5.45 | 0.69 | 7.31 | 0.79 | 8.00 | 0.71 | 7.76 |
| | 1900 | 0.71 | 4.74 | 0.88 | 6.56 | 0.78 | 7.31 | 0.68 | 7.31 |
| 7 | 0100 | 2.12 | 7.31 | 2.43 | 7.53 | 2.88 | 7.31 | 2.26 | 7.11 |
| | 0700 | 2.01 | 8.53 | 2.41 | 8.00 | 2.76 | 7.76 | 2.40 | 7.76 |
| | 1300 | 1.79 | 7.31 | 2.12 | 9.14 | 2.42 | 8.83 | 2.06 | 8.26 |
| | 1900 | 1.67 | 6.40 | 1.79 | 8.83 | 2.06 | 9.14 | 1.62 | 9.14 |
| 8 | 0100 | 1.53 | 9.48 | 1.75 | 9.48 | 2.00 | 9.48 | 1.48 | 9.14 |
| | 0700 | 1.38 | 10.67 | 1.78 | 11.13 | 1.81 | 11.64 | 1.59 | 11.13 |
| | 1300 | 1.71 | 11.64 | 1.88 | 12.19 | 1.89 | 11.13 | 1.59 | 11.13 |
| | 1900 | 0.98 | 12.80 | 1.47 | 12.80 | 1.65 | 12.19 | 1.32 | 12.19 |
| 9 | 0100 | 0.84 | 12.19 | 1.23 | 12.19 | 1.37 | 12.80 | 1.10 | 12.80 |
| | 0700 | 0.57 | 13.47 | 0.96 | 12.80 | 1.02 | 12.19 | 0.79 | 12.19 |
| | 1300 | 0.48 | 12.80 | 0.75 | 12.19 | 0.89 | 12.80 | 0.79 | 12.19 |
| | 1900 | 0.38 | 12.19 | 0.59 | 12.80 | 0.76 | 12.19 | 0.54 | 12.19 |
| 10 | 0100 | 0.46 | 12.80 | 0.59 | 12.19 | 0.69 | 12.19 | 0.59 | 12.19 |
| | 0700 | 0.39 | 12.19 | 0.61 | 12.80 | 0.67 | 12.19 | 0.64 | 12.19 |
| | 1300 | 0.43 | 12.80 | 0.59 | 12.19 | 0.60 | 12.80 | 0.47 | 12.19 |
| | 1900 | 0.33 | 12.80 | 0.55 | 12.19 | 0.54 | 12.19 | 0.47 | 12.80 |
| 11 | 0100 | 0.35 | 13.47 | 0.57 | 12.19 | 0.64 | 11.64 | 0.46 | 12.19 |
| | 0700 | 0.36 | 11.64 | 0.62 | 12.80 | 0.72 | 12.80 | 0.50 | 12.80 |
| | 1300 | 0.41 | 12.80 | 0.63 | 12.19 | 0.68 | 12.80 | 0.60 | 12.19 |
| | 1900 | 0.39 | 12.19 | 0.58 | 12.19 | 0.62 | 12.19 | 0.50 | 11.64 |
| 12 | 0100 | 0.38 | 15.06 | 0.53 | 11.13 | 0.63 | 11.13 | 0.49 | 11.64 |
| | 0700 | 0.34 | 14.22 | 0.52 | 14.22 | 0.57 | 14.22 | 0.43 | 15.06 |
| | 1300 | 0.31 | 14.22 | 0.43 | 13.47 | 0.49 | 13.47 | 0.38 | 14.22 |
| | 1900 | 0.28 | 13.47 | 0.43 | 13.47 | 0.51 | 13.47 | 0.31 | 13.47 |
| 13 | 0100 | 0.27 | 13.47 | 0.38 | 13.47 | 0.43 | 13.47 | 0.31 | 13.47 |
| | 0700 | 0.22 | 13.47 | 0.33 | 13.47 | 0.38 | 13.47 | 0.24 | 12.80 |
| | 1300 | 0.28 | 12.80 | 0.33 | 12.19 | 0.35 | 12.80 | 0.41 | 12.80 |
| | 1900 | 0.23 | 11.13 | 0.31 | 12.19 | 0.35 | 12.19 | 0.39 | 11.64 |
| 14 | 0100 | 0.19 | 12.80 | 0.27 | 12.19 | 0.31 | 11.64 | 0.34 | 12.19 |
| | 0700 | 0.17 | 12.19 | 0.26 | 12.19 | 0.30 | 12.19 | 0.31 | 11.13 |
| | 1300 | 0.20 | 11.64 | 0.27 | 11.64 | 0.28 | 12.19 | 0.35 | 12.80 |
| | 1900 | 0.19 | 11.64 | 0.25 | 11.13 | 0.27 | 11.64 | 0.35 | 12.19 |
| 15 | 0100 | 0.17 | 12.19 | 0.23 | 12.19 | 0.26 | 11.64 | 0.33 | 11.64 |
| | 0700 | 0.15 | 10.24 | 0.23 | 12.80 | 0.26 | 12.80 | 0.28 | 12.80 |
| | 1300 | 0.19 | 12.19 | 0.25 | 11.64 | 0.27 | 12.80 | 0.31 | 11.13 |
| | 1900 | 0.19 | 8.53 | 0.27 | 10.67 | 0.29 | 11.13 | 0.43 | 8.53 |
| 16 | 0100 | 0.20 | 11.64 | 0.24 | 11.13 | 0.31 | 11.64 | 0.41 | 4.66 |
| | 0700 | 0.32 | 5.22 | 0.39 | 5.33 | 0.43 | 5.12 | 0.61 | 5.02 |
| | 1300 | 0.32 | 5.33 | 0.39 | 5.02 | 0.44 | 6.40 | 0.72 | 5.82 |
| | 1900 | 0.36 | 6.56 | 0.41 | 6.74 | 0.46 | 6.56 | 0.63 | 5.33 |

* Electronic problems

(Continued)

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(Sheet 1 of 2)

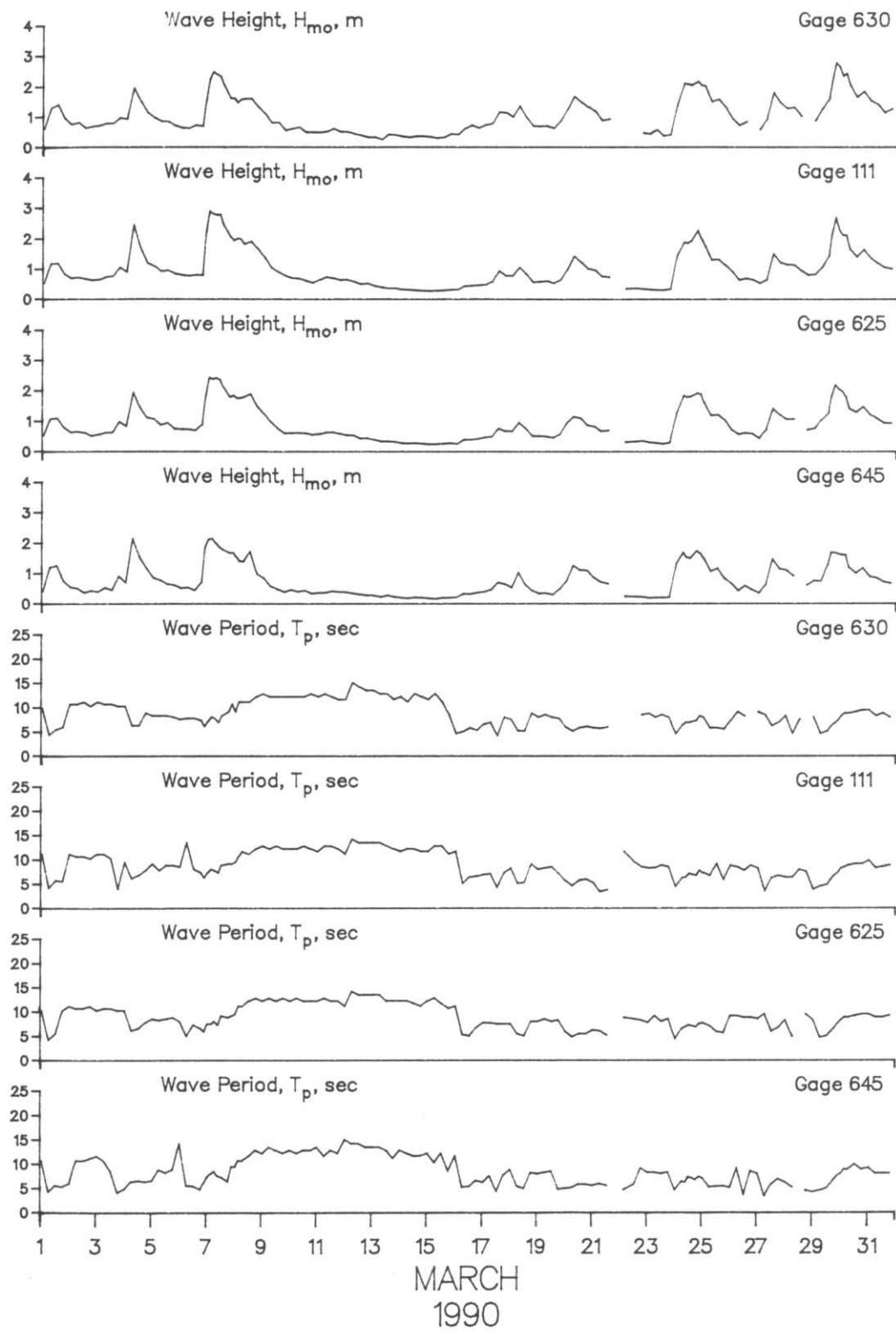
Table 3: Wave Data

Mar 1990

| Day | Hour | 645 | | 625 | | 111 | | 630 | |
|---------|------|----------------|-------------|-----------------|-------------|---------------|-------------|---------------|-------------|
| | | Baylor at 7+80 | Hmo,m T,sec | Baylor at 18+60 | Hmo,m T,sec | Pressure Gage | Hmo,m T,sec | Offshtr Wvrdr | Hmo,m T,sec |
| 17 | 0100 | 0.39 | 6.24 | 0.46 | 7.76 | 0.48 | 6.92 | 0.73 | 6.56 |
| | 0700 | 0.47 | 7.53 | 0.49 | 7.76 | 0.57 | 7.11 | 0.78 | 6.92 |
| | 1300 | 0.70 | 4.34 | 0.76 | 7.53 | 0.92 | 4.27 | 1.15 | 4.20 |
| | 1900 | 0.65 | 7.76 | 0.68 | 7.53 | 0.77 | 7.31 | 1.14 | 8.00 |
| 18 | 0100 | 0.53 | 8.83 | 0.66 | 7.53 | 0.77 | 8.26 | 1.00 | 7.53 |
| | 0700 | 1.03 | 5.45 | 0.95 | 5.45 | 1.05 | 5.12 | 1.35 | 5.22 |
| | 1300 | 0.63 | 4.92 | 0.76 | 5.02 | 0.82 | 5.22 | 0.97 | 5.12 |
| | 1900 | 0.43 | 8.26 | 0.51 | 8.00 | 0.56 | 9.14 | 0.68 | 8.83 |
| 19 | 0100 | 0.33 | 8.00 | 0.50 | 8.00 | 0.57 | 8.00 | 0.68 | 8.00 |
| | 0700 | 0.34 | 8.26 | 0.49 | 8.53 | 0.60 | 8.26 | 0.68 | 8.53 |
| | 1300 | 0.29 | 8.53 | 0.45 | 8.00 | 0.53 | 8.53 | 0.61 | 8.00 |
| | 1900 | 0.48 | 4.74 | 0.56 | 8.26 | 0.63 | 7.11 | 0.86 | 7.76 |
| 20 | 0100 | 0.74 | 4.92 | 0.94 | 5.95 | 0.98 | 5.57 | 1.26 | 5.95 |
| | 0700 | 1.25 | 5.12 | 1.15 | 4.83 | 1.41 | 4.57 | 1.67 | 5.12 |
| | 1300 | 1.11 | 5.82 | 1.11 | 5.45 | 1.22 | 5.69 | 1.48 | 5.82 |
| | 1900 | 1.10 | 5.82 | 0.87 | 5.45 | 1.00 | 5.95 | 1.32 | 6.09 |
| 21 | 0100 | 0.86 | 5.57 | 0.82 | 6.24 | 0.96 | 5.22 | 1.18 | 5.82 |
| | 0700 | 0.71 | 5.95 | 0.67 | 6.09 | 0.75 | 3.37 | 0.87 | 5.69 |
| | 1300 | 0.65 | 5.57 | 0.69 | 5.22 | 0.72 | 3.71 | 0.91 | 5.95 |
| | 1900 | | | | | | | | |
| 22 | 0100 | Power Failure | | | | | | | |
| | 0700 | | | | | | | | |
| | 1300 | 0.24 | 5.82 | 0.34 | 8.53 | 0.37 | 9.48 | * | |
| | 1900 | 0.23 | 9.14 | 0.36 | 8.26 | 0.34 | 8.53 | 0.47 | 8.53 |
| 23 | 0100 | 0.19 | 8.26 | 0.31 | 7.76 | 0.32 | 8.26 | 0.43 | 8.83 |
| | 0700 | 0.20 | 8.26 | 0.29 | 9.14 | 0.30 | 8.26 | 0.57 | 8.00 |
| | 1300 | 0.20 | 8.00 | 0.26 | 8.00 | 0.30 | 8.83 | 0.37 | 8.53 |
| | 1900 | 0.21 | 8.26 | 0.30 | 8.53 | 0.33 | 8.53 | 0.39 | 8.00 |
| 24 | 0100 | 1.33 | 4.57 | 1.27 | 4.41 | 1.46 | 4.41 | 1.41 | 4.57 |
| | 0700 | 1.68 | 6.40 | 1.84 | 6.56 | 1.87 | 6.24 | 2.11 | 6.40 |
| | 1300 | 1.50 | 7.31 | 1.80 | 7.31 | 1.93 | 7.11 | 2.05 | 6.92 |
| | 1900 | 1.74 | 6.74 | 1.92 | 6.92 | 2.26 | 6.74 | 2.18 | 7.31 |
| 25 | 0100 | 1.50 | 7.11 | 1.61 | 7.76 | 1.77 | 7.31 | 2.04 | 8.00 |
| | 0700 | 1.07 | 5.22 | 1.19 | 7.11 | 1.29 | 6.74 | 1.51 | 5.82 |
| | 1300 | 1.17 | 5.33 | 1.21 | 5.95 | 1.30 | 9.14 | 1.57 | 5.82 |
| | 1900 | 0.82 | 5.45 | 1.03 | 5.69 | 1.11 | 5.82 | 1.32 | 5.57 |
| 26 | 0100 | 0.67 | 5.12 | 0.71 | 9.14 | 0.90 | 8.83 | 0.93 | 7.31 |
| | 0700 | 0.43 | 9.14 | 0.56 | 9.14 | 0.63 | 8.53 | 0.71 | 9.14 |
| | 1300 | 0.59 | 3.61 | 0.61 | 8.83 | 0.68 | 7.76 | 0.82 | 8.26 |
| | 1900 | 0.46 | 8.53 | 0.58 | 8.83 | 0.63 | 8.83 | 1.27 | 8.83 |
| 27 | 0100 | 0.34 | 8.00 | 0.44 | 8.53 | 0.53 | 8.26 | 0.59 | 9.14 |
| | 0700 | 0.62 | 3.41 | 0.71 | 9.48 | 0.63 | 3.51 | 0.91 | 8.53 |
| | 1300 | 1.47 | 5.82 | 1.41 | 5.95 | 1.50 | 6.24 | 1.80 | 6.24 |
| | 1900 | 1.15 | 6.92 | 1.22 | 6.74 | 1.21 | 6.74 | 1.46 | 6.92 |
| 28 | 0100 | 1.11 | 6.24 | 1.06 | 8.26 | 1.14 | 6.40 | 1.27 | 8.26 |
| | 0700 | 0.93 | 5.22 | 1.06 | 4.92 | 1.12 | 6.40 | 1.31 | 4.66 |
| | 1300 | 0.71 | 4.74 | 0.80 | 8.26 | 0.94 | 8.00 | 1.02 | 7.53 |
| | 1900 | 0.63 | 4.57 | 0.72 | 9.48 | 0.79 | 7.53 | * | |
| 29 | 0100 | 0.76 | 4.27 | 0.77 | 8.26 | 0.81 | 3.82 | 0.88 | 8.00 |
| | 0700 | 0.75 | 4.57 | 1.04 | 4.74 | 1.04 | 4.49 | 1.26 | 4.66 |
| | 1300 | 1.29 | 5.02 | 1.25 | 5.02 | 1.42 | 4.83 | 1.58 | 5.12 |
| | 1900 | 1.69 | 6.74 | 2.19 | 6.56 | 2.68 | 6.74 | 2.79 | 6.74 |
| 30 | 0100 | 1.62 | 8.00 | 1.98 | 8.26 | 2.12 | 8.26 | 2.35 | 8.26 |
| | 0700 | 1.19 | 8.83 | 1.42 | 8.83 | 1.65 | 8.83 | 2.05 | 8.83 |
| | 1300 | 1.01 | 9.85 | 1.30 | 9.14 | 1.40 | 9.14 | 1.65 | 9.14 |
| | 1900 | 1.17 | 8.83 | 1.48 | 9.48 | 1.64 | 9.14 | 1.84 | 9.48 |
| 31 | 0100 | 0.90 | 9.14 | 1.22 | 9.48 | 1.35 | 9.85 | 1.53 | 9.48 |
| | 0700 | 0.84 | 8.00 | 1.09 | 8.83 | 1.19 | 8.26 | 1.41 | 8.26 |
| | 1300 | 0.72 | 8.00 | 0.94 | 8.83 | 1.05 | 8.53 | 1.14 | 8.83 |
| | 1900 | 0.67 | 8.00 | 0.92 | 9.14 | 1.00 | 8.83 | 1.25 | 8.00 |
| Mean | | 0.73 | 8.41 | 0.86 | 8.98 | 0.95 | 8.81 | 1.00 | 8.78 |
| Std dev | | 0.49 | 3.04 | 0.51 | 2.53 | 0.58 | 2.78 | 0.56 | 2.61 |

* Electronic problems

(Sheet 2 of 2)



PART IV: CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the data.

Table 4: Current Data
Mar 1990

| Alongshore Cross-shore Resultant ---- Time | Pier Measurements | | | | Beach Measurements (500m Updrift) | | | | Current Meter | | |
|--|--------------------------------|-------|-----|-----------------------------------|--------------------------------------|-------|-----|----------------------------------|---------------|-------|-----|
| | Dye at (579 m) (surface) | Speed | Dir | Dye at Mid-Surf Zone (surface) | Distance from Baseline (m) | Speed | Dir | Dye 12m offshore (surface) | Location | Speed | Dir |
| Day | | | | | | | | | | | |
| 1 0100-Along Cross Result | | | | | | | | | | 8 | N |
| 1 0700-Along Cross Result | 51 | S | | 87 | S | | | 99 | S | 11 | S |
| | 13 | on | | 22 | on | | | | North | 6 | off |
| | 52 | 174 | | 90 | 174 | | | | | 13 | 131 |
| 1 1300-Along Cross Result | | | | | | | | | | 15 | S |
| 1 1900-Along Cross Result | | | | | | | | | | 11 | off |
| | | | | | | | | | | 19 | 124 |
| 2 0100-Along Cross Result | | | | | | | | | | 2 | S |
| 2 0700-Along Cross Result | 28 | N | | 102 | N | | | 30 | N | 1 | off |
| | 4 | off | | 10 | on | | | | South | 5 | on |
| | 28 | 349 | | 102 | 334 | | | | | 14 | 319 |
| 2 1300-Along Cross Result | | | | | | | | | | 13 | N |
| 2 1900-Along Cross Result | | | | | | | | | | 4 | on |
| | | | | | | | | | | 14 | 323 |
| 3 0100-Along Cross Result | | | | | | | | | | 18 | N |
| 3 0700-Along Cross Result | 6 | N | | 32 | N | | | 15 | S | 6 | on |
| | 4 | off | | 8 | off | | | | South | 16 | 318 |
| | 7 | 13 | | 33 | 354 | | | | | 8 | N |
| 3 1300-Along Cross Result | | | | | | | | | | 2 | on |
| 3 1900-Along Cross Result | | | | | | | | | | 8 | 326 |
| 4 0100-Along Cross Result | | | | | | | | | | 15 | S |
| 4 0700-Along Cross Result | 61 | S | | 152 | S | | | 96 | S | 4 | off |
| | 15 | on | | 38 | on | | | | North | 7 | 100 |
| | 63 | 174 | | 157 | 174 | | | | | 8 | 134 |
| 4 1300-Along Cross Result | | | | | | | | | | 26 | S |
| 4 1900-Along Cross Result | | | | | | | | | | 12 | off |
| | | | | | | | | | | 29 | 135 |
| 5 0100-Along Cross Result | | | | | | | | | | 24 | S |
| 5 0700-Along Cross Result | 9 | S | | 68 | N | | | 18 | N | 9 | off |
| | 0 | | | 34 | on | | | | South | 26 | 139 |
| | 9 | 160 | | 76 | 313 | | | | | 8 | S |
| 5 1300-Along Cross Result | | | | | | | | | | 6 | off |
| 5 1900-Along Cross Result | | | | | | | | | | 10 | 123 |

KEY = All speeds in cm/sec

N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

Table 4: Current Data (Continued)
Mar 1990

| Alongshore Cross-shore Resultant Time Day | Pier Measurements | | | | Beach Measurements | | | | Current Meter | |
|---|--------------------------------|-----------------------------------|-------------------------------------|---|----------------------------------|-----------------|-------|-----|--|------------------|
| | Dye at (579 m) (surface) | Dye at Mid-Surf Zone (surface) | Distance from Baseline (m) | | Dye 12m offshore (surface) | Location | Speed | Dir | 0.9 km Offshore Depth -5.6m (NGVD) ID #519 | Speed |
| 6 0100-Along Cross Result | | | | | | | | | 8 | S |
| 6 0700-Along Cross Result | 17 1 17 | S off 157 | 140 | . | 76 0 76 | N 0 340 | | | 1 4 4 | off 84 153 |
| 6 1300-Along Cross Result | | | | | | | | | 9 6 11 | S off 126 |
| 6 1900-Along Cross Result | | | | | | | | | 17 16 23 | S off 117 |
| 7 0100-Along Cross Result | | | | | | | | | 35 19 40 | S off 132 |
| 7 0700-Along Cross Result | 68 34 76 | S on 187 | 189 | | 76 50 91 | S on 193 | | 30 | 44 25 51 | S off 130 |
| 7 1300-Along Cross Result | | | | | | | | | 30 17 34 | S off 130 |
| 7 1900-Along Cross Result | | | | | | | | | 28 13 31 | S off 135 |
| 8 0100-Along Cross Result | | | | | | | | | 22 5 23 | S off 147 |
| 8 0700-Along Cross Result | 28 4 28 | S off 151 | 177 | | 23 8 24 | S on 179 | | 44 | 25 18 31 | S off 124 |
| 8 1300-Along Cross Result | | | | | | | | | 13 14 19 | S off 113 |
| 8 1900-Along Cross Result | | | | | | | | | 3 13 13 | S off 83 |
| 9 0100-Along Cross Result | | | | | | | | | 4 3 5 | S off 123 |
| 9 0700-Along Cross Result | 28 7 29 | N off 354 | 140 | | 87 0 87 | N 0 340 | | 46 | 12 1 12 | N on 335 |
| 9 1300-Along Cross Result | | | | | | | | | 17 12 21 | N on 305 |
| 9 1900-Along Cross Result | | | | | | | | | 13 5 14 | N on 319 |
| 10 0100-Along Cross Result | | | | | | | | | 13 7 15 | N on 312 |
| 10 0700-Along Cross Result | 5 0 5 | N 140 340 | | | 22 2 22 | N off 346 | | 18 | 13 7 15 | N off 8 |
| 10 1300-Along Cross Result | | | | | | | | | 2 4 4 | N off 43 |
| 10 1900-Along Cross Result | | | | | | | | | 9 12 15 | S off 107 |

KEY = All speeds in cm/sec
 N = Northward, Shore parallel
 S = Southward, Shore parallel
 on = onshore off = offshore

Table 4: Current Data (Continued)
Mar 1990

| Alongshore Cross-shore Resultant Time Day | Pier Measurements . | | | | | | Beach Measurements (500m Updrift) | | | Current Meter | |
|---|--------------------------------|-----|-------------------------------------|-------|----------------------------------|--|--------------------------------------|-------|-----|--|-----|
| | Dye at (579 m) (surface) | | Dye at Mid-Surf Zone (surface) | | Dye 12m offshore (surface) | | Location | Speed | Dir | 0.9 km Offshore Depth -5.6m (NGVD) ID #519 | |
| | Speed | Dir | Distance from Baseline (m) | Speed | Dir | | | | | Speed | Dir |
| 11 0100-Along Cross Result | | | | | | | | | | 12 | S |
| | | | | | | | | | | 4 | off |
| | | | | | | | | | | 13 | 142 |
| 11 0700-Along Cross Result | 11 | N | | 32 | N | | | 5 | N | 0 | |
| | 11 | off | 140 | 10 | off | | South | | | 1 | off |
| | 16 | 24 | | 33 | 357 | | | | | 1 | 70 |
| 11 1300-Along Cross Result | | | | | | | | | | 5 | N |
| | | | | | | | | | | 3 | on |
| | | | | | | | | | | 6 | 309 |
| 11 1900-Along Cross Result | | | | | | | | | | 4 | N |
| | | | | | | | | | | 2 | off |
| | | | | | | | | | | 4 | 7 |
| 12 0100-Along Cross Result | | | | | | | | | | 3 | S |
| | | | | | | | | | | 2 | on |
| | | | | | | | | | | 4 | 194 |
| 12 0700-Along Cross Result | 7 | N | | 11 | N | | | 21 | N | 8 | N |
| | 11 | off | 140 | 0 | | | South | | | 3 | on |
| | 13 | 36 | | 11 | 340 | | | | | 9 | 319 |
| 12 1300-Along Cross Result | | | | | | | | | | 5 | N |
| | | | | | | | | | | 2 | on |
| | | | | | | | | | | 5 | 318 |
| 12 1900-Along Cross Result | | | | | | | | | | 8 | N |
| | | | | | | | | | | 6 | off |
| | | | | | | | | | | 10 | 17 |
| 13 0100-Along Cross Result | | | | | | | | | | 9 | S |
| | | | | | | | | | | 0 | |
| | | | | | | | | | | 9 | 160 |
| 13 0700-Along Cross Result | 4 | S | | 0 | | | | 9 | N | 4 | N |
| | 10 | off | 140 | 5 | off | | South | | | 4 | on |
| | 11 | 92 | | 5 | 70 | | | | | 6 | 295 |
| 13 1300-Along Cross Result | | | | | | | | | | 4 | S |
| | | | | | | | | | | 9 | off |
| | | | | | | | | | | 10 | 94 |
| 13 1900-Along Cross Result | | | | | | | | | | 5 | S |
| | | | | | | | | | | 3 | off |
| | | | | | | | | | | 6 | 129 |
| 14 0100-Along Cross Result | | | | | | | | | | 10 | S |
| | | | | | | | | | | 4 | off |
| | | | | | | | | | | 11 | 138 |
| 14 0700-Along Cross Result | 8 | S | | 2 | N | | | 6 | N | 3 | N |
| | 11 | off | 140 | 8 | off | | South | | | 2 | on |
| | 14 | 104 | | 8 | 59 | | | | | 4 | 306 |
| 14 1300-Along Cross Result | | | | | | | | | | 1 | S |
| | | | | | | | | | | 6 | off |
| | | | | | | | | | | 6 | 79 |
| 14 1900-Along Cross Result | | | | | | | | | | 0 | |
| | | | | | | | | | | 0 | |
| | | | | | | | | | | 0 | |
| 15 0100-Along Cross Result | | | | | | | | | | 3 | S |
| | | | | | | | | | | 3 | off |
| | | | | | | | | | | 4 | 115 |
| 15 0700-Along Cross Result | 4 | N | | 4 | N | | | 5 | N | 0 | |
| | 8 | off | 140 | 4 | off | | South | | | 1 | off |
| | 9 | 43 | | 6 | 25 | | | | | 1 | 70 |
| 15 1300-Along Cross Result | | | | | | | | | | 1 | S |
| | | | | | | | | | | 11 | off |
| | | | | | | | | | | 11 | 75 |
| 15 1900-Along Cross Result | | | | | | | | | | 0 | |
| | | | | | | | | | | 3 | on |
| | | | | | | | | | | 3 | 250 |

KEY = All speeds in cm/sec
N = Northward, Shore parallel
S = Southward, Shore parallel
on = onshore off = offshore

Table 4: Current Data (Continued)
Mar 1990

| Alongshore Cross-shore Resultant Time Day | Pier Measurements | | | | Beach Measurements | | | | Current Meter | |
|---|--------------------------------|--------------------------------------|-------------------------------------|------------------|--------------------|----------------------------------|----------|-------|---------------|--|
| | Dye at (579 m) (surface) | Dye at Mid-Surf Zone (surface) | Distance from Baseline (m) | Speed | Dir | Dye 12m offshore (surface) | Location | Speed | Dir | 0.9 km Offshore Depth -5.6m (NGVD) ID #519 |
| 16 0100-Along Cross Result | | | | | | | | | | 2 S |
| 16 0700-Along Cross Result | 20 11 23 | N off 9 | 140 | 20 5 21 | N off 354 | | South | 18 | N | 1 on 2 187 |
| 16 1300-Along Cross Result | | | | | | | | | | 6 N |
| 16 1900-Along Cross Result | | | | | | | | | | 4 on 7 306 |
| 17 0100-Along Cross Result | | | | | | | | | | 13 N |
| 17 0700-Along Cross Result | 47 0 47 | N 140 340 | | 102 36 108 | N on 321 | | South | 69 | N | 5 on 7 316 |
| 17 1300-Along Cross Result | | | | | | | | | | 12 N |
| 17 1900-Along Cross Result | | | | | | | | | | 13 on 15 312 |
| 18 0100-Along Cross Result | | | | | | | | | | 19 N |
| 18 0700-Along Cross Result | 3 2 4 | S off 133 | 140 | 23 0 23 | N on 340 | | South | 17 | N | 8 on 11 317 |
| 18 1300-Along Cross Result | | | | | | | | | | 20 N |
| 18 1900-Along Cross Result | | | | | | | | | | 11 on 23 311 |
| 19 0100-Along Cross Result | | | | | | | | | | 9 N |
| 19 0700-Along Cross Result | 22 0 22 | N 140 340 | | 61 30 68 | N on 313 | | South | 65 | N | 6 on 9 306 |
| 19 1300-Along Cross Result | | | | | | | | | | 9 S |
| 19 1900-Along Cross Result | | | | | | | | | | 5 off 10 131 |
| 20 0100-Along Cross Result | | | | | | | | | | 2 N |
| 20 0700-Along Cross Result | 55 0 55 | S 152 160 | | 152 0 152 | S North | | | 63 | S | 3 off 18 139 |
| 20 1300-Along Cross Result | | | | | | | | | | 50 139 |
| 20 1900-Along Cross Result | | | | | | | | | | 21 S |
| | | | | | | | | | | 7 off 22 142 |
| | | | | | | | | | | 21 S |
| | | | | | | | | | | 4 off 21 149 |

KEY = All speeds in cm/sec
N = Northward, Shore parallel
S = Southward, Shore parallel
on = onshore off = offshore

Table 4: Current Data (Continued)
Mar, 1990

| Alongshore Cross-shore Resultant Time Day | Pier Measurements | | | | Beach Measurements (500m Updrift) | | | | Current Meter | |
|---|--------------------------------|-----------------|-------------------------------------|-------------------|--------------------------------------|-----|----------|-----|---------------|-----|
| | Dye at (579 m) (surface) | | Distance from Baseline (m) | | Dye 12m offshore (surface) | | Location | | Speed | Dir |
| | Speed | Dir | Speed | Dir | Speed | Dir | Speed | Dir | Speed | Dir |
| 21 0100-Along Cross Result | | | | | | | | | 15 | S |
| 21 0700-Along Cross Result | 30 8 31 | S off 146 | 140 | 102 102 144 | S on 205 | | 81 | S | 2 | off |
| 21 1300-Along Cross Result | | | | | | | | | 15 | 152 |
| 21 1900-Along Cross Result | | | | | | | | | 11 | S |
| 22 0100-Along Cross Result | | | | | | | | | 4 | off |
| 22 0700-Along Cross Result | 7 10 12 | S off 104 | 140 | 22 0 22 | N 340 | | 24 | N | 12 | 140 |
| 22 1300-Along Cross Result | | | | | | | | | 10 | S |
| 22 1900-Along Cross Result | | | | | | | | | 3 | off |
| 23 0100-Along Cross Result | | | | | | | | | 10 | 143 |
| 23 0700-Along Cross Result | 7 14 15 | N off 43 | 140 | 16 2 17 | N off 349 | | 13 | N | 7 | N |
| 23 1300-Along Cross Result | | | | | | | | | 9 | on |
| 23 1900-Along Cross Result | | | | | | | | | 12 | 292 |
| 24 0100-Along Cross Result | | | | | | | | | 7 | N |
| 24 0700-Along Cross Result | 36 13 38 | S on 179 | 213 | 87 35 94 | S on 182 | | 46 | S | 9 | on |
| 24 1300-Along Cross Result | | | | | | | | | 11 | 288 |
| 24 1900-Along Cross Result | | | | | | | | | 10 | N |
| 25 0100-Along Cross Result | | | | | | | | | 8 | on |
| 25 0700-Along Cross Result | 41 14 43 | S on 179 | 177 | 30 38 49 | S on 211 | | 33 | S | 13 | 301 |
| 25 1300-Along Cross Result | | | | | | | | | 1 | 340 |
| 25 1900-Along Cross Result | | | | | | | | | 12 | S |
| | | | | | | | | | 6 | off |
| | | | | | | | | | 13 | 133 |
| | | | | | | | | | 23 | S |
| | | | | | | | | | 12 | off |
| | | | | | | | | | 26 | 132 |
| | | | | | | | | | 21 | S |
| | | | | | | | | | 11 | off |
| | | | | | | | | | 24 | 132 |
| | | | | | | | | | 39 | S |
| | | | | | | | | | 19 | off |
| | | | | | | | | | 43 | 134 |
| | | | | | | | | | 30 | S |
| | | | | | | | | | 12 | off |
| | | | | | | | | | 32 | 138 |
| | | | | | | | | | 32 | S |
| | | | | | | | | | 12 | off |
| | | | | | | | | | 34 | 139 |
| | | | | | | | | | 26 | S |
| | | | | | | | | | 9 | off |
| | | | | | | | | | 28 | 141 |
| | | | | | | | | | 31 | S |
| | | | | | | | | | 15 | off |
| | | | | | | | | | 34 | 134 |

KEY = All speeds in cm/sec
 N = Northward, Shore parallel
 S = Southward, Shore parallel
 on = onshore off = offshore

Table 4: Current Data (Continued)
Mar 1990

| Alongshore Cross-shore Resultant Time | Pier Measurements | | | | Beach Measurements (500m Updrift) | | | | Current Meter | | |
|--|--------------------------------|-----------------------------------|-------------------------------------|-------|--------------------------------------|----------|-------|-----|--|-------|-----|
| | Dye at (579 m) (surface) | Dye at Mid-Surf Zone (surface) | Distance from Baseline (m) | Speed | Dye 12m offshore (surface) | Location | Speed | Dir | 0.9 km Offshore Depth -5.6m (NGVD) ID #519 | Speed | Dir |
| Day | Speed | Dir | | Speed | Dir | | | | | | |
| 26 0100-Along Cross Result | | | | | | | | | 28 | S | |
| 26 0700-Along Cross Result | 47 | S | | 23 | S | | 19 | S | 13 | off | |
| | 0 | | 140 | 2 | on | | | | 31 | 135 | |
| | 47 | 160 | | 23 | 166 | | | | | | |
| 26 1300-Along Cross Result | | | | | | | | | 29 | S | |
| | | | | | | | | | 4 | off | |
| | | | | | | | | | 29 | 152 | |
| 26 1900-Along Cross Result | | | | | | | | | 10 | S | |
| | | | | | | | | | 1 | off | |
| | | | | | | | | | 10 | 154 | |
| 27 0100-Along Cross Result | | | | | | | | | 0 | | |
| | | | | | | | | | 1 | on | |
| | | | | | | | | | 1 | 250 | |
| 27 0700-Along Cross Result | 61 | S | | 51 | S | | 47 | S | 2 | S | |
| | 0 | | 189 | 76 | on | | | | 4 | off | |
| | 61 | 160 | | 92 | 216 | | | | 4 | 97 | |
| 27 1300-Along Cross Result | | | | | | | | | 19 | S | |
| | | | | | | | | | 7 | off | |
| | | | | | | | | | 20 | 140 | |
| 27 1900-Along Cross Result | | | | | | | | | 16 | S | |
| | | | | | | | | | 3 | off | |
| | | | | | | | | | 16 | 149 | |
| 28 0100-Along Cross Result | | | | | | | | | 21 | S | |
| | | | | | | | | | 9 | off | |
| | | | | | | | | | 23 | 137 | |
| 28 0700-Along Cross Result | 11 | S | | 7 | S | | 48 | S | 14 | S | |
| | 3 | on | 140 | 4 | off | | | | 7 | off | |
| | 12 | 177 | | 8 | 133 | | | | 16 | 133 | |
| 28 1300-Along Cross Result | | | | | | | | | 13 | S | |
| | | | | | | | | | 7 | off | |
| | | | | | | | | | 15 | 132 | |
| 28 1900-Along Cross Result | | | | | | | | | 5 | S | |
| | | | | | | | | | 3 | off | |
| | | | | | | | | | 6 | 129 | |
| 29 0100-Along Cross Result | | | | | | | | | 8 | S | |
| | | | | | | | | | 5 | off | |
| | | | | | | | | | 9 | 128 | |
| 29 0700-Along Cross Result | 3 | S | | 16 | N | | 17 | S | 4 | N | |
| | 10 | on | 152 | 6 | on | | | | 3 | on | |
| | 11 | 232 | | 17 | 321 | | | | 5 | 303 | |
| 29 1300-Along Cross Result | | | | | | | | | 13 | S | |
| | | | | | | | | | 6 | off | |
| | | | | | | | | | 14 | 135 | |
| 29 1900-Along Cross Result | | | | | | | | | 18 | S | |
| | | | | | | | | | 7 | off | |
| | | | | | | | | | 19 | 139 | |
| 30 0100-Along Cross Result | | | | | | | | | 20 | S | |
| | | | | | | | | | 10 | off | |
| | | | | | | | | | 22 | 133 | |
| 30 0700-Along Cross Result | 15 | S | | 102 | N | | 74 | N | 18 | S | |
| | 8 | off | 140 | 36 | on | | | | 8 | off | |
| | 17 | 133 | | 108 | 321 | | | | 20 | 136 | |
| 30 1300-Along Cross Result | | | | | | | | | 27 | S | |
| | | | | | | | | | 6 | off | |
| | | | | | | | | | 28 | 147 | |
| 30 1900-Along Cross Result | | | | | | | | | 28 | S | |
| | | | | | | | | | 21 | off | |
| | | | | | | | | | 35 | 123 | |

KEY = All speeds in cm/sec
N = Northward, Shore parallel
S = Southward, Shore parallel
on = onshore off = offshore

Table 4: Current Data (Concluded)
Mar 1990

| Alongshore Cross-shore Resultant Time | Pier Measurements | | | | Beach Measurements (500m Updrift) | | | | Current Meter | |
|--|--------------------------------|--------------------------------------|-------------------------------------|-----|--------------------------------------|----------|-------|-----|-----------------------|---------|
| | Dye at (579 m) (surface) | Dye at Mid-Surf Zone (surface) | Distance from Baseline (m) | | Dye 12m offshore (surface) | Location | Speed | Dir | Depth -5.6m (NGVD) | ID #519 |
| Day | Speed | Dir | Speed | Dir | Speed | Dir | Speed | Dir | Speed | Dir |
| 31 0100-Along Cross Result | | | | | | | | | 30 | S |
| 31 0700-Along Cross Result | 36 | S | 36 | N | | | 13 | off | 13 | 137 |
| | 4 | off | 0 | | | | | | 33 | |
| | 36 | 154 | 36 | 340 | | South | | | 6 | S |
| 31 1300-Along Cross Result | | | | | | | | | 5 | off |
| 31 1900-Along Cross Result | | | | | | | | | 8 | 120 |
| | | | | | | | | | 17 | S |
| | | | | | | | | | 7 | off |
| | | | | | | | | | 18 | 138 |
| | | | | | | | | | 15 | S |
| | | | | | | | | | 7 | off |
| | | | | | | | | | 17 | 135 |

KEY = All speeds in cm/sec
 N = Northward, Shore parallel
 S = Southward, Shore parallel
 on = onshore off = offshore

PART V: SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is orientated 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A jar along with a thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The jar is removed, the temperature read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the surface visibility.

Table 5: Supplemental Observations

Mar 1990

| Day | Time | Wave Approach | | Radar Wave Angle deg from True N | Width of Surf Zone,m | Water Characteristics at Pier End | | |
|-----|------|---------------|-----------|--|-------------------------|--------------------------------------|-----------------|------------------|
| | | Primary | Secondary | | | Temp.,C | Density g/cc | Secchi Vis.,m |
| 1 | 0830 | 40 | 70 | inoperative | 87 | 8.3 | 1.0240 | 2.1 |
| 2 | 0847 | 60 | 75 | inoperative | 56 | 8.6 | 1.0241 | 2.7 |
| 3 | 1210 | 85 | | inoperative | 53 | 9.1 | 1.0246 | 2.4 |
| 4 | 0940 | 30 | | inoperative | 229 | 8.6 | 1.0236 | 1.5 |
| 5 | 0850 | 80 | 55 | inoperative | 87 | 8.3 | 1.0212 | 2.7 |
| 6 | 0805 | 100 | | inoperative | 55 | 8.9 | 1.0203 | 2.1 |
| 7 | 0745 | 35 | | inoperative | 370 | 9.7 | 1.0205 | 0.9 |
| 8 | 0755 | 75 | 25 | | 213 | 8.0 | 1.0200 | 0.6 |
| 9 | 0850 | 75 | | | 70 | 8.3 | 1.0217 | 0.9 |
| 10 | 0905 | 70 | | | 53 | 9.4 | 1.0246 | 2.4 |
| 11 | 0745 | 75 | 50 | | 12 | 8.9 | 1.0246 | 2.4 |
| 12 | 0830 | 90 | 115 | | 44 | 9.7 | 1.0246 | 2.1 |
| 13 | 0830 | 95 | | | 14 | 11.1 | 1.0246 | 2.7 |
| 14 | 1020 | 95 | 125 | | 6 | 13.3 | 1.0230 | 4.0 |
| 15 | 0900 | 105 | | | 8 | 12.2 | 1.0238 | 4.3 |
| 16 | 0825 | 95 | | | 23 | 10.0 | 1.0250 | 3.4 |
| 17 | 1000 | 105 | | | 50 | 10.0 | 1.0254 | 1.5 |
| 18 | 1105 | 50 | 70 | inoperative | 58 | 11.7 | 1.0249 | 1.8 |
| 19 | 0830 | 80 | | | 49 | 10.6 | 1.0255 | 4.0 |
| 20 | 0830 | 30 | | | 70 | 11.1 | 1.0224 | 1.5 |
| 21 | 0830 | 20 | | | 47 | 10.0 | 1.0243 | 2.1 |
| 22 | 0850 | 55 | 90 | inoperative | 43 | 10.6 | 1.0244 | 2.7 |
| 23 | 0823 | 105 | | inoperative | 37 | 10.0 | 1.0246 | 4.0 |
| 24 | 1030 | 50 | 15 | inoperative | 268 | 10.0 | 1.0254 | 0.9 |
| 25 | 1115 | 45 | 15 | inoperative | 131 | 11.1 | 1.0206 | 0.9 |
| 26 | 0820 | 65 | | inoperative | 52 | 10.6 | 1.0210 | 1.5 |
| 27 | 0827 | 35 | | | 130 | 10.6 | 1.0208 | 1.5 |
| 28 | 0830 | 50 | | | 67 | 10.3 | 1.0228 | 1.5 |
| 29 | 0835 | 80 | | | 107 | 10.6 | 1.0228 | 0.9 |
| 30 | 1013 | 80 | 60 | | 93 | 11.1 | 1.0225 | 1.8 |
| 31 | 1130 | 85 | | | 75 | 10.9 | 1.0216 | 2.1 |

PART VI: WATER LEVELS

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 4 along with a list of mean and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 6 contains the time at the center of each 12.42-hr tidal cycle and the range, high, low, and mean water levels during each tidal cycle.

FRF Tide Heights

Mar 1990

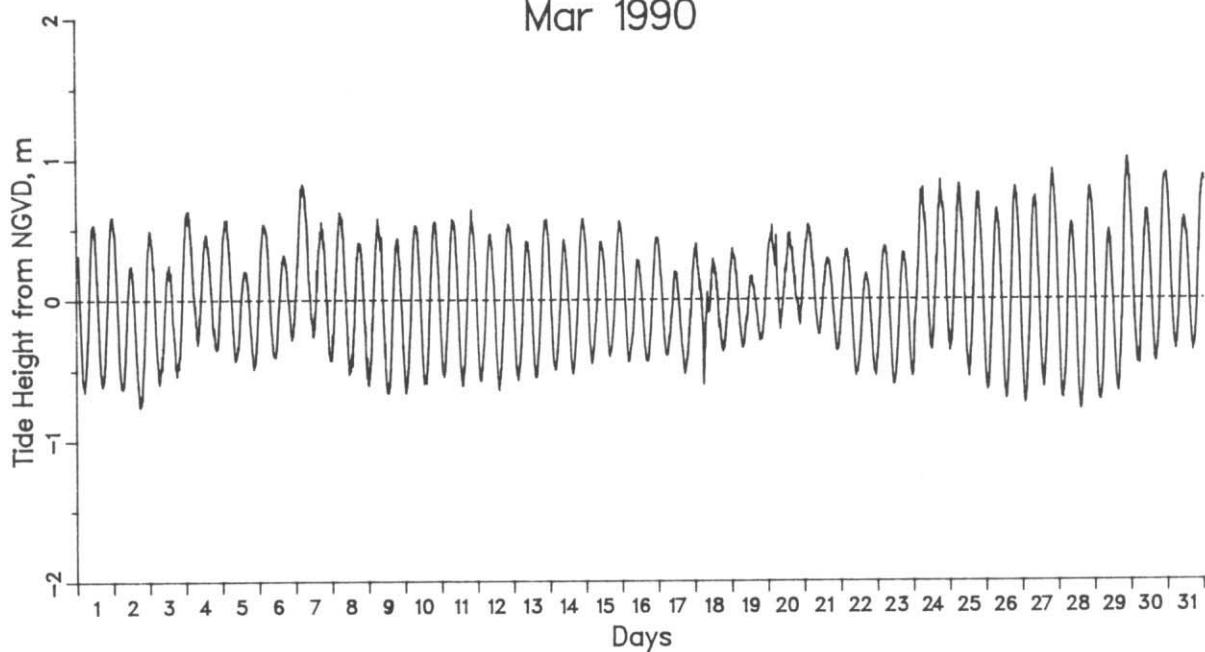


Figure 4. Water Level Time History

Monthly Water Levels, m NGVD

Extreme Low = -0.78 on day 28 at 1400 EST
Extreme High = 1.01 on day 29 at 2118 EST
Monthly Mean = 0.02
Mean Low = -0.50
Mean High = 0.54
Mean Range = 1.05

Table 6: Water Levels, m NGVD

| | | Mar 1990 | | | |
|-----|----------------|----------|------|-------|-------|
| Day | Mid-Cycle Time | Low | High | Mean | Range |
| 1 | 612 | -0.65 | 0.53 | -0.04 | 1.18 |
| 1 | 1837 | -0.61 | 0.59 | -0.02 | 1.20 |
| 2 | 703 | -0.62 | 0.27 | -0.17 | 0.89 |
| 2 | 1928 | -0.75 | 0.49 | -0.18 | 1.24 |
| 3 | 753 | -0.59 | 0.24 | -0.15 | 0.84 |
| 3 | 2018 | -0.54 | 0.63 | 0.02 | 1.17 |
| 4 | 843 | -0.32 | 0.46 | 0.12 | 0.78 |
| 4 | 2109 | -0.35 | 0.57 | 0.08 | 0.92 |
| 5 | 934 | -0.43 | 0.44 | -0.05 | 0.87 |
| 5 | 2159 | -0.49 | 0.54 | 0.00 | 1.03 |
| 6 | 1024 | -0.41 | 0.46 | -0.02 | 0.87 |
| 6 | 2249 | -0.28 | 0.82 | 0.20 | 1.11 |
| 7 | 1115 | -0.26 | 0.75 | 0.21 | 1.01 |
| 7 | 2340 | -0.43 | 0.62 | 0.08 | 1.05 |
| 8 | 1205 | -0.53 | 0.57 | 0.00 | 1.10 |
| 9 | 30 | -0.61 | 0.58 | -0.04 | 1.18 |
| 9 | 1255 | -0.66 | 0.45 | -0.09 | 1.12 |
| 10 | 121 | -0.66 | 0.53 | -0.06 | 1.19 |
| 10 | 1346 | -0.59 | 0.55 | -0.02 | 1.15 |
| 11 | 211 | -0.55 | 0.57 | 0.03 | 1.12 |
| 11 | 1436 | -0.61 | 0.64 | -0.01 | 1.25 |
| 12 | 301 | -0.58 | 0.47 | -0.04 | 1.04 |
| 12 | 1527 | -0.64 | 0.54 | -0.04 | 1.18 |
| 13 | 352 | -0.57 | 0.41 | -0.05 | 0.98 |
| 13 | 1617 | -0.55 | 0.57 | 0.00 | 1.12 |
| 14 | 442 | -0.50 | 0.43 | -0.03 | 0.93 |
| 14 | 1707 | -0.53 | 0.58 | 0.01 | 1.10 |
| 15 | 532 | -0.45 | 0.41 | 0.00 | 0.86 |
| 15 | 1758 | -0.40 | 0.56 | 0.06 | 0.96 |
| 16 | 623 | -0.44 | 0.28 | -0.06 | 0.72 |
| 16 | 1848 | -0.44 | 0.44 | -0.01 | 0.88 |
| 17 | 713 | -0.40 | 0.20 | -0.09 | 0.59 |
| 17 | 1938 | -0.53 | 0.39 | -0.11 | 0.92 |
| 18 | 804 | -0.60 | 0.28 | 0.00 | 0.89 |
| 18 | 2029 | -0.37 | 0.36 | -0.03 | 0.73 |
| 19 | 854 | -0.34 | 0.18 | -0.07 | 0.52 |
| 19 | 2119 | -0.29 | 0.53 | 0.06 | 0.82 |
| 20 | 944 | -0.21 | 0.47 | 0.17 | 0.68 |
| 20 | 2210 | -0.18 | 0.53 | 0.19 | 0.71 |
| 21 | 1035 | -0.25 | 0.34 | 0.06 | 0.59 |
| 21 | 2300 | -0.37 | 0.35 | -0.01 | 0.72 |
| 22 | 1125 | -0.54 | 0.19 | -0.16 | 0.73 |
| 22 | 2350 | -0.54 | 0.37 | -0.08 | 0.92 |
| 23 | 1216 | -0.60 | 0.33 | -0.12 | 0.93 |
| 24 | 41 | -0.55 | 0.79 | 0.09 | 1.34 |
| 24 | 1306 | -0.36 | 0.85 | 0.23 | 1.21 |
| 25 | 131 | -0.37 | 0.82 | 0.22 | 1.18 |
| 25 | 1356 | -0.55 | 0.76 | 0.12 | 1.30 |
| 26 | 222 | -0.64 | 0.64 | 0.02 | 1.28 |
| 26 | 1447 | -0.70 | 0.80 | 0.04 | 1.50 |
| 27 | 312 | -0.73 | 0.73 | 0.01 | 1.46 |
| 27 | 1537 | -0.62 | 0.92 | 0.12 | 1.55 |
| 28 | 402 | -0.70 | 0.54 | -0.05 | 1.24 |
| 28 | 1628 | -0.78 | 0.80 | -0.01 | 1.58 |
| 29 | 453 | -0.71 | 0.49 | -0.10 | 1.20 |
| 29 | 1718 | -0.66 | 1.01 | 0.13 | 1.66 |
| 30 | 543 | -0.46 | 0.63 | 0.12 | 1.09 |
| 30 | 1808 | -0.45 | 0.90 | 0.21 | 1.34 |
| 31 | 634 | -0.36 | 0.66 | 0.16 | 1.01 |
| 31 | 1859 | -0.37 | 0.88 | 0.18 | 1.25 |

PART VII: NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Zeiss surveying system; a Zeiss Elta-2 first-order, self-recording electronic theodolite distance meter in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in February and the two surveys in March on profile line 188, located 517 m south of the pier. Built by the first storm (6-7 March) in March the nearshore bar (160 m) continued to develop. Further offshore the storm bar (360 m) migrated 40 m shoreward.

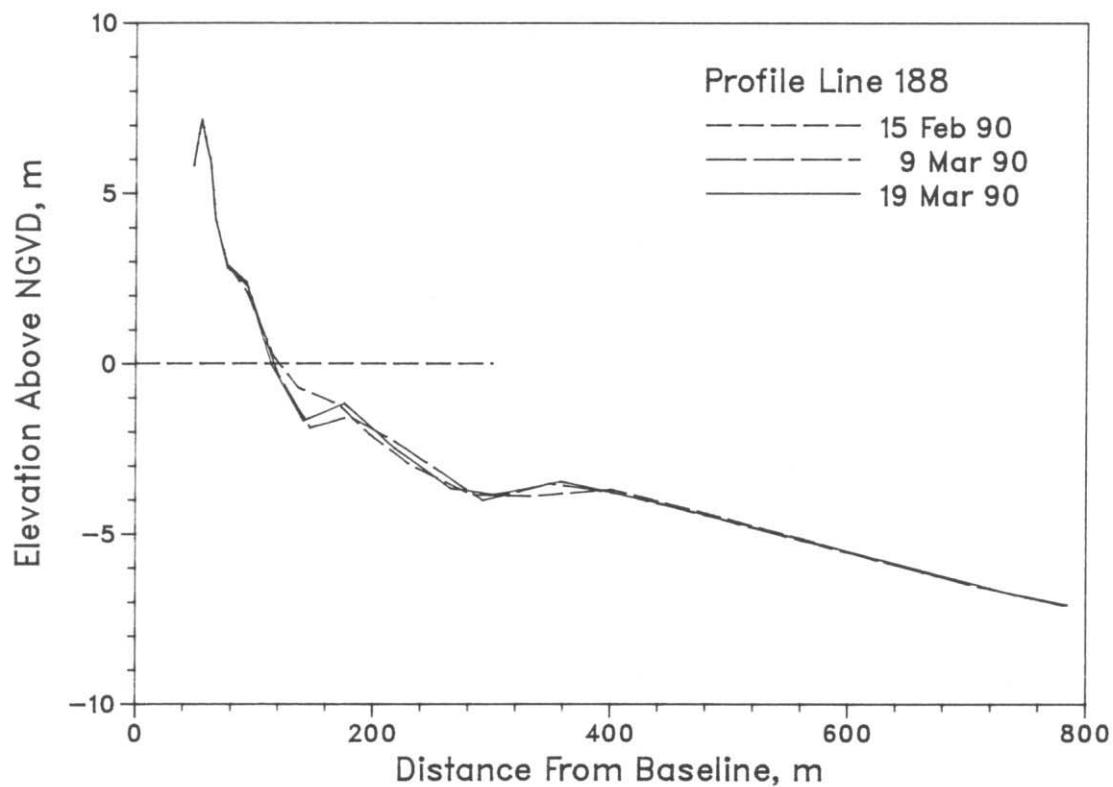


Figure 5. Monthly CRAB profiles on profile 188 -
517 m south of pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1990. Causes for the changes visible on the envelope include the development of the nearshore bar and trough (120 - 160 m) and the shoreward movement (320 - 360 m) of the storm bar.

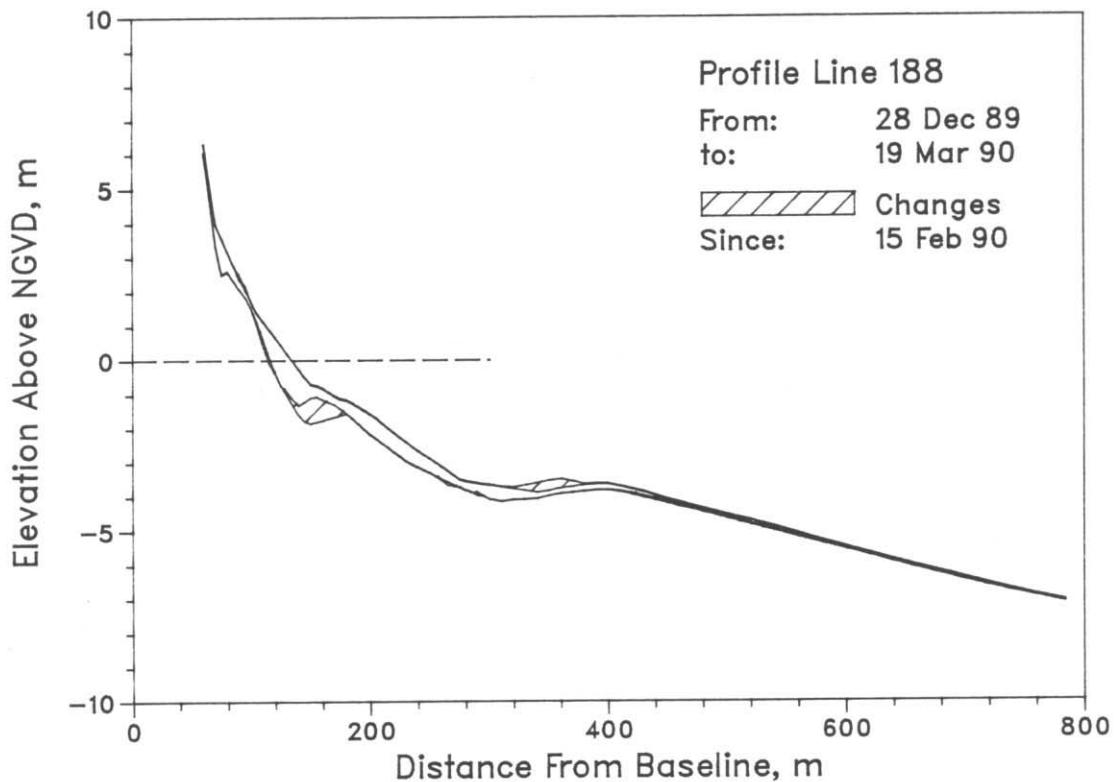


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. Figure 7 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 7 December. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

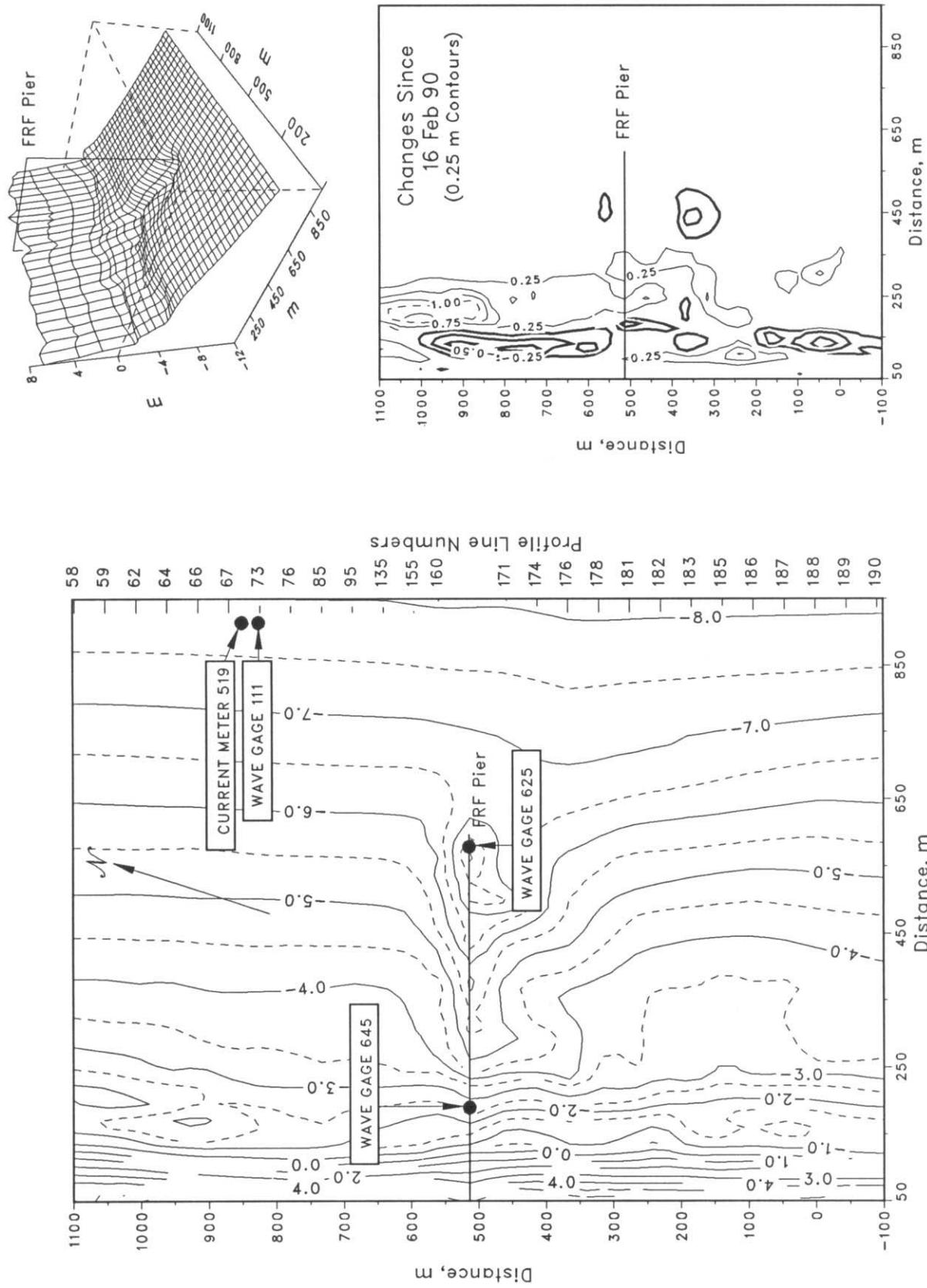


Figure 7. FRF bathymetry 19 Mar 90 depths relative to NGVD

PART VIII. SPECIAL EVENTS

A. Storm Data Collection. The following list identifies times when the significant wave height at the seaward end of the pier (i.e. as measured near the end of the pier) exceeded 2 m and four contiguous 34 minute wave records were obtained every three hours:

| <u>Start</u> | <u>End</u> |
|---------------|---------------|
| 6 Mar (2234) | 7 Mar (1442) |
| 29 Mar (1708) | 29 Mar (2200) |

B. Storm Synopsis.

6-7 March - Winds from a strong Canadian high pressure system began to generate storm waves at the FRF late on 6 March. The maximum H_{mo} (at gage 625) of 2.50 m ($T_p = 7.53$ sec) was attained at 0208 EST on 7 March. Maximum winds (from northeast) exceeding 16 m/s occurred at 0542 EST also on 7 March.

29 March - Developing over South Carolina on 29 March this storm rapidly moved to the northeast being located off the Virginia coast by 30 March. Maximum winds approaching 16 m/s peaked at 1634 EST on 29 March with the maximum H_{mo} (at gage 625) of 2.22 m ($T_p = 6.92$ sec) occurring later the same day at 1934 EST. The minimum atmospheric pressure of 1014 mb was recorded at 0400 EST on 30 March. Total precipitation was 30 mm.

Distribution List

Government Agencies:

| | |
|----------------------------|-------------------------------|
| OCE | U.S. Geological Survey |
| BERH | U.S. National Park Service |
| NAO | U.S. Naval Academy |
| NASA/Wallops Flight Center | U.S. Naval Civil Eng. Lab |
| NOAA (NOS, NWS) | U.S. Naval Fac. Eng. Com. |
| SAD | U.S. Naval Oceanographic Off. |
| SAW | U.S. Naval Research Lab |

Colleges/Universities:

| | |
|-------------------------------|------------------------------|
| California Inst. of Tech. | Stockton State College |
| East Carolina University | University of Akron |
| Florida Inst. of Tech. | University of Delaware |
| Harvard University | University of Florida |
| Naval Post Graduate School | University of Maryland |
| NC State University | University of Miami |
| Old Dominion University | University of North Carolina |
| Oregon State University | University of N. Colorado |
| Prince George's College | University of Rhode Island |
| Rutgers University | University of Virginia |
| Scripps Inst. of Oceanography | Va. Inst. of Marine Science |
| Southern Illinois University | |

Others:

| | |
|------------------------------|-------------------------------|
| City of Va. Beach, VA | MEC Systems Corporation |
| Coastal Barge Corporation | Moffatt & Nichol, Eng. |
| Coastal and Est. Res., Inc. | Offshore Coastal Technologies |
| Coastal Science & Eng., Inc. | Mr. Rowland |
| Dr. Galvin | Mr. Savage |
| GEOMET Tech., Inc. | Sea Port Supply Corp. |
| Greenhorne & O'Mara, Inc. | Shell Development |
| Dr. Hylton | Sherwood Industries |
| Mary Marr, Inc. | Mr. & Mrs. Valpey |
| Mr. Mason | WCTI-TV |
| Masonite Corporation | SEASUN Power Systems |

Foreign:

W. F. Baird & Asso. Coastal Engineers, Ltd (Canada)
Queen's University, Ontario (Canada)
Ministry of Construction, Coastal Division (Japan)
Norwegian Hydrodynamic Laboratories (Norway)
University of New South Wales (Australia)
University of Sydney (Australia)